REMARKS

Prior to entry of the present amendment, claims 1-23 and 49-57 were pending in the application. Claims 1, 8, 13-15, 50, 54, and 55 have been amended. Claims 7, 56, and 57 have been canceled without prejudice. No new matter has been added. Claims 1-6, 8-23, and 49-55 are pending after entry of the present amendment.

CLAIM AMENDMENTS

Claim 1 has been amended to incorporate the features formerly recited in claim 7, which has been canceled. Claim 1 has further been amended to explicitly recite that the change of airflow resulting from contact with the aerofoil diffuser reduces acoustic emissions. Support for this amendment can be found in the specification at least at paragraph [0073].

Claims 8, 13-15, 50, 54, and 55 have been amended to more clearly recite features of the invention.

ALLOWABLE SUBJECT MATTER

Claims 21-23 are indicated as being allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claims 21-23 depend indirectly from claim 1.

Because Applicants respectfully submit that as-amended claim 1 is allowable, claims 21-23 have been retained in dependent form. Accordingly, Applicant respectfully submits that claims 21-23 are allowable.

CLAIM REJECTIONS

35 U.S.C. § 112 Rejection

Claim 55 stands rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. In particular, the Examiner asserts that the term "altered" is a relative term that renders the claim indefinite.

Claim 55 has been amended to eliminate the term "altered" and to instead recite that "the cross-sectional shape and length of each of the reduced diameter sections is configured to 'tune'

the system . . . ." The amended language recites structure that would be understood by a person skilled in the art. Accordingly, Applicants respectfully request that the indefiniteness rejection of claim 55 be withdrawn.

35 U.S.C. § 102 Rejection (Li)

Claims 1, 3, 5, and 8-17 stand rejected under 35 U.S.C. § 102 as being anticipated by U.S. Patent No. 5,910,688 (Li).

Claim 1

Independent claim 1 has been amended to recite a structural feature, and a resultant function, that are not disclosed or taught by Li. In particular, the specific shape of the aerofoil diffuser ring yields superior acoustic characteristics for the wind turbine, as described in detail below. These acoustic characteristics are summarized in a brochure available on the web site of Renewable Devices Swift Turbines Limited, the assigned of the present application, at http://www.renewabledevices.com/images/stories/swift_turbine/swift%20rooftop%20wind%20energy%20system.pdf. A printed copy of the brochure is provided herewith as Appendix A. The brochure emphasizes that the wind turbine of the present invention is "virtually inaudible" (page 5) and has acoustic emissions of "<35 dBA (across all wind speeds)" (page 6).

The wind turbine of the present invention is intended to be used in built-up areas, and in particular on roofs of domestic or commercial buildings. See original specification at page 1, lines 3-8. Inherent in such built-up areas is turbulent airflow created due to the movement of air over and around building structures. As a consequence of the turbulent airflow, variations in blade tip speed in smaller roof-mountable wind turbines create intermittent unwanted noise, as well as inefficient power generation. See original specification at page 2, lines 1-6 and page 16, lines 8-10. It will be appreciated that excessive noise is particularly undesirable when the wind turbine is to be used on domestic buildings.

Discussion of General Prior Art

It is well known to use fixed aerodynamic concentrators located up-wind of a rotor for the purpose of concentrating airflow through the rotor plane to achieve increased power output from a larger scale wind turbine. Similarly, it is well known to employ fixed diffusers located

down-wind of the rotor with the aim of sucking more air through the rotor plane. However, the size and shape of fixed concentrators and diffusers makes their use technically impractical for smaller scale roof-mountable furling wind turbines which must necessarily be lightweight and mobile.

Existing turbine designs fail to suppress the extremely noisy acoustic emissions associated with smaller conventional rotors, as confirmed in an article by Paul Gipe entitled "Noise from Small Wind Turbines: An Unaddressed Issue." Mr Gipe is a wind energy expert and author of numerous books on the subject of wind energy. A copy of the article (available at http://www.wind-works.org/articles/noiseswt.html#Sources_of_Small_Turbine_Noise) is provided herewith as Appendix B, and a copy of Mr. Gipe's biography (available at http://www.wind-works.org/bio.html) is provided herewith as Appendix C.

Applicants note that the article provides a link to several sound clips that demonstrate the type of undesirable acoustic emissions that are typical in smaller scale wind turbines but are eliminated in Applicants' claimed wind turbine. Applicants respectfully request, for example, that the Examiner listen to a sound clip provided on the enclosed CD, which is available at http://www.ndsu.nodak.edu/ndsu/klemen/air5.wav. Duplicate copies of the CD are submitted, as required under 37 C.F.R. § 1.52(e)(4).

Applicants further note that the copyright notice at the foot of the aforementioned article is generally contemporaneous with the priority date of the present invention (i.e., the article is noted as having been published in the summer of 2001 and the Internet version is copyrighted in 2003, and the foreign priority application for the present application was filed on March 18, 2003), which confirms that unwanted acoustic emissions from small scale wind turbines were known to be a serious problem as of the priority date.

Summary of the Present Invention

A unique aspect of the rotor of the present invention is that it incorporates an aerofoil diffuser that is connected to the outer tips of the rotor blades to imitate the effect of a conventional diffuser which is not attached to the rotor blades. A diffuser such as the one claimed by Applicants is not disclosed by Li or any other of the cited references. Most importantly, the inventive diffuser allows air which is naturally shed from the blades during rotation to do so without any significant noise emissions.

It is well known in the art that when incoming airflow interacts with a turbine's rotating blades, a helical airflow pattern is created downstream. In addition, it is well known that a component of the airflow is forced centrifugally (radially) outward towards the blade tip. When airflow leaves the blade tip, a considerable ripping noise can be heard as the tip vortex is shed, because the motion of the vortex changes immediately from a radial direction to a downstream direction. For this reason, considerable research has gone into refining the shape of blade tips of large scale wind turbines with the aim of reducing acoustic emissions.

The inventors of the present invention have realized that acoustic emissions for smaller-scale roof mountable wind turbines in domestic and commercial settings must necessarily be far less than for large scale wind turbines, in order to increase public acceptance. The inventors approached the problem of acoustic emissions from an entirely new angle resulting in a novel and inventive rotor which serves to "soften" the shedding of the tip vortex to the extent that no significant noise is produced.

As a starting point, the inventors applied their knowledge of conventional diffuser design theory (for a fixed, non-rotating diffuser) and analyzed the flow pattern of a notional molecule of air entering the rotor and interacting with the divergent inner (blade side) surface of a diffuser. The inner surface of a conventional diffuser (e.g. as disclosed in U.S. Patent No. 4,075,500 and U.S. Patent No. 4,021,135) is typically elongate in a downstream direction so as to maximize pressure differentials serving to increase air speed locally through the rotor plane.

The invention defined by claim 1, as amended, lies in the inventors' surprising discovery that by attaching a novel aerofoil-shaped diffuser to the blade tips, which necessarily move at the same rotational speed as the rotor, the aforementioned notional molecule of air will effectively "see" the same path (i.e. same length and curvature) as that described above in relation to a fixed, non-rotating diffuser. As a result of the airflow characteristics created by this design, acoustic emissions are dramatically reduced. In particular, the notional molecule of air travels radially outward along the blade tip and transfers onto the aerofoil diffuser's surface near its leading edge where it continues its radial movement. However, since the aerofoil diffuser is rotating, the molecule of air will also move circumferentially (oppositely to the rotation direction) relative to the diffuser's aerofoil shaped surface until it reaches the opposite trailing edge of the aerofoil diffuser. The path traced by the molecule of air from the point at which it contacts the leading edge of the rotating diffuser until the point at which it leaves the opposing trailing edge of the

diffuser largely corresponds to the shape (i.e., curvature) and length of the path of a molecule travelling along the inner surface of a fixed, non-rotating diffuser. Yet the rotating diffuser of the present invention is much smaller than known fixed diffusers, and does not require separate mounting as do fixed diffusers. Therefore, Applicant's rotor, including the aerofoil diffuser, is more technically and commercially practical in many situations.

The effect of the rotating aerofoil diffuser is that airflow is held on the diffuser's surface for a longer time period, thus slowing the speed of the airflow leaving the outer tips of the blades. The diffuser causes the air moving through the blades to be released more gradually and more gently over a larger surface area than the rapid and violent vortex shedding that occurs with conventional wind turbine blade tips. As a result, blade tip vertex noise is dramaticly reduced.

To see (but not hear!) the claimed wind turbine in action, Applicants respectfully request that the Examiner view a clip from a news broadcast by the BBC in which the noise of a flapping flag and other background noise can be heard, but the wind turbine is inaudible. The clip is provided on the enclosed CD, and is available at http://www.renewabledevices.com/swift/videoclips.html. The lack of noise generated by the wind turbine is a direct result of the aerofoil shaped diffuser recited in claim 1. The original specification describes reduction of acoustic noise emissions at least at page 3, lines 4-12 and page 16, lines 13-22, and in originally filed claims 7 and 8.

Li Does Not Disclose the Features Recited in Claim 1

As amended, claim 1 recites a rotor for a roof-mountable wind turbine (i.e. a smaller-scale turbine) and further explicitly recites that the aerofoil diffuser causes a change of airflow direction that results in a reduction in acoustic emissions.

The term "aerofoil" has a specific and well understood meaning in the art, and denotes a member having a cross-sectional surface profile capable of influencing the direction and speed of air flow over its surfaces so as to provide a desired reaction force. Aircraft components such as an airplane wing and a propeller blade are typically described as having an "aerofoil" shape which causes them to impart lift to an aircraft as the components are moved through the air. An aerofoil comprises a smoothly curved shape that allows streamlines of air to flow over the aerofoil surface.

Li discloses a windmill comprising a central hub (14), an annular outer ring (10), and twisted blades (11) connecting the hub (14) to the ring (10). Li at col. 2, lines 25-28 and FIGS. 2A, 2B. It is readily apparent that the outer ring (10) disclosed in Li cannot be equated with the aerofoil diffuser of the present invention, for at least the basic reason that ring (10) disclosed by Li is not a diffuser at all. Rather, the ring (10) is on the inlet side of the windmill and facilitates the capture of air entering the blades. See Li at col. 2, lines 57-59 (describing FIG. 3 and explaining that the annular-shaped funnel (23) fixedly engaged with the outer ring (10) "further improve[s] wind capturing efficiency") and col. 2, lines 49-50 (indicating wind direction in FIG. 1 by the fact that element (19) is a "tail fin"). Indeed, the Examiner notes in paragraph 18 of the Office Action that Li "fails to disclose the aerofoil diffuser extending downstream from the outer tips of the blades." Applicant respectfully submits that a diffuser, by definition, must extend downstream from the outer tips of the blades in order to be a diffuser.

Therefore, in accordance with the ring (10) being on the inlet and not the outlet side of the windmill, wind flows from right to left in Li FIG. 1. As a result, it is understood that wind is initially captured by the outer portions of the blades (11) (as shown in FIGS. 2A, 2B) and flows inwardly along the blades (11), such that the air is released from the blades (11) at or near the inner hub (14). Thus, the operation of Li's blades (11) is completely opposite to that of Applicants' claimed invention, wherein air flow proceeds outwardly along the blades to the aerofoil diffuser.

Moreover, Li fails to disclose that the ring (10) has an aerofoil shape. Indeed, as shown in the cross-section of FIG. 2B and the front view of FIG. 2A, the outer ring (10) is described as merely "an annular ring with an L-shaped cross-section" having an annular ring portion and an end flange (101). Li at col. 2, lines 32-37. In contrast to the smoothly shaped surface of the claimed diffuser, it is quite clear that the sharp corners of the L-shaped outer ring (10) disclosed in Li cannot act as an aerofoil.

Further, the blades (11) of Li's turbine are each fixed by rivets to the end flange (101) of the L-shaped ring (10) in such a manner that there cannot be a smooth transition of airflow between the blades (11) and the ring (10). Li at col. 2, line 35-37; FIGS. 2A, 2B.

Still further, there is no hint or suggestion anywhere in Li that the windmill is designed to achieve improved acoustic characteristics, let alone that the shape of the outer ring (10), or the manner of the connection of the ring (10) to the blades (11), is adapted for the purpose of re-

directing and diffusing airflow to obtain an acoustic emissions benefit. Indeed, Li teaches that the sole purpose of the outer ring (10) is to ensure that the blades are "strongly supported" in strong wind flow conditions. Li at col. 1, lines 52-57.

Li in view of McCabe Does Not Disclose the Features Recited in Claim 1

Because the features of claim 7 have been incorporated into claim 1, it is appropriate to address the Examiner's obviousness rejection of claim 7 set forth in paragraph 21 of the Office Action, with regard to the teachings of U.S. Patent No. 5,599,172 (McCabe). In making a case for obviousness under 35 U.S.C. § 103, the Examiner must: (1) determine the scope and content of the prior art; (2) ascertain the differences between the prior art and the claims at issue; (3) resolve the level of ordinary skill in the pertinent art; and (4) evaluate evidence of secondary considerations. *Graham v. John Deere*, 383 U.S. 1 (1960); *KSR Int'l Co. v. Teleflex Inc.*, 127 S.Ct. 1727 (2007).

The Examiner contends that McCabe discloses an aerofoil diffuser, and particularly points out that "apparatus claims must be structurally distinguishable from the prior art," citing MPEP § 2114, *In re Danly*, 263 F.2d 844, 847 (CCPA 1959), and *Hewlett-Packard Co. v. Bausch & Lomb, Inc.*, 909 F.2d 1464, 1469 (Fed. Cir. 1990). Applicants agree and respectfully submit that the Examiner's arguments and citations cut in favor of, rather than against, patentability of as-amended claim 1, because it is readily apparent that McCabe does not disclose a structure that in any way resembles an aerofoil diffuser. (It is also noted that McCabe does not disclose any functionally beneficial reduction in acoustic noise resulting from the disclosed structure.)

As shown in FIG. 2, McCabe teaches "a shroud (18)" having "an exhaust section (24) and a trailing edge section (26)." McCabe at col. 2, lines 19-20. The "shroud (18) [is] preferably made of a sheet metal such as aluminum." McCabe at col. 2, lines 27-28. McCabe says nothing further about the exhaust section (24) and trailing edge (26), so that a person of ordinary skill in the art would clearly understand that the generally conical exhaust section (24) and the generally cylindrical trailing edge (26) have essentially no profile, i.e., each has a cross-section with no more shape than a thin piece of sheet metal. Clearly then, the exhaust section (24) and trailing edge (26) cannot be construed as, and would never be confused with, an aerofoil diffuser.

Therefore, the claimed design is indeed structurally different from the McCabe design, and moreover, as a result, yields functionally different performance.

It is noted that while McCabe discusses at length (col. 3, line 48 – col. 4, line 43) and depicts in detail (FIGS. 7J-7P) blades shaped as "airfoils," it makes absolutely no mention any portion of the shroud (18) being aerofoil-shaped. Moreover, there is no hint or suggestion anywhere in McCabe that the apparatus achieves improved acoustic characteristics, let alone that the shape of the shroud (18), or the manner of its connection to the blades is adapted for the purpose of re-directing and diffusing airflow to obtain an acoustic emissions benefit.

The Examiner attempts to base the rejection on the notion that it would have been obvious to combine the diffuser of McCabe with the windmill of Li "for the purpose of providing more torque at lower operating speeds," which is the purpose touted by McCabe. See McCabe at col. 1, lines 42-45. However, because neither McCabe nor Li teaches an aerofoil shaped diffuser, this assertion has no bearing on the claimed invention.

Secondary Indicia of Nonobviousness

Notwithstanding the fact that the cited prior art fails to disclose an aerofoil diffuser, the presence of secondary considerations further shows the nonbviousness of the claimed invention, as follows.

First, connecting a diffuser ring to outer edge of the blades goes against the conventional wisdom. In normal practice, small scale wind turbines seek to minimize weight and cost, and thus would not be inclined to add a component to the end of the turbine blades.

Second, the degree of improvement in terms of acoustic emissions characteristics was entirely unexpected to the inventors, as persons of ordinary skill in the art.

Third, competing designers of small scale wind turbines have failed to achieve comparable acoustic performance, even though the need for quiet operation is well understood to be a desirable feature. For example, Zephyr Corporation makes the AirDolphin turbine, which is the only other small turbine known to Applicants that claims to reduce noise. A brochure discussing features of the AirDolphin is provided in Appendix D and is available at http://www.zephyreco.co.jp/en/main_pro_airdolphin.htm#Features07. However, Applicants respectfully request that the Examiner view a video clip (in particular @ 14-18 seconds and at 3 minutes, 14-25 seconds) to observe that significant noise emissions are in fact still produced by

the AirDolphin. The video clip is provided on the enclosed CD, and is available at http://www.youtube.com/watch?v=mjbg787qQnk.

Li Does Not Disclose the Features of Claims 3, 5, and 8-17

With regard to claim 3, Li's blades (11) are connected near the trailing edge of the inlet ring (10), not near the leading edge of a diffuser as claimed.

With regard to claim 5, while it is correct that Li's inlet ring (10) extends upstream from the outer tips of the blades (11), the ring (10) is not a diffuser because it does not extend downstream from the outer tips of the blades (11).

With regard to claim 8, it would be impossible for Li's windmill to function in the claimed manner because, as discussed above, wind flows inwardly from the outer portion of the blades (11) to the hub (14), and not outwardly as in Applicant's wind turbine.

Claims 9-15 depend from claim 1, and are therefore patentable for at least the same reasons as claim 1.

With regard to claims 16-18, Li does not disclose at least two tail fins. The Examiner contends that it would have been obvious to use two tail fins in view of Li's single tail fin, but Applicant respectfully notes that this rejection is being made under § 102, which requires a single reference to show each and every element of the claimed invention. MPEP § 2131; *Verdegaal Bros. v. Union Oil Co. of Calif.*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

Accordingly, for at least the foregoing reasons, Applicants respectfully request that the rejection of claims 1, 3, 5, and 8-17 be withdrawn.

35 U.S.C. § 103 Rejection (Li in view of McCabe)

Claims 2, 4, 6, and 7 stand rejected under 35 U.S.C. § 103 as being obvious under Li in view of U.S. Patent No. 5,599,172 (McCabe). Claim 7 has been canceled and its features incorporated into claim 1.

As discussed above, McCabe fails to remedy the deficiencies of Li with regard to disclosing an aerofoil shaped diffuser. Therefore, claims 2, 4, and 6 are patentable for at least the same reasons as claim 1.

Accordingly, Applicants respectfully request that the rejection of claims 2, 4, and 6 be withdrawn.

35 U.S.C. § 103 Rejection (Li in view of Aylor)

Claims 18-20 stand rejected under 35 U.S.C. § 103 as being obvious under Li in view of U.S. Patent No. 5,591,004 (Aylor).

The turbine of Aylor does not comprise a tail fin functioning as a furling means to rotate the rotor about the directional axis, as recited in claim 18 (and claim 14 from which claim 18 indirectly depends). Therefore, Aylor does not teach a moveable tail fin hingedly mounted for rotation about a tangential hinge line. Rather, as the Examiner correctly points out, Aylor discloses hinged wind gates (18) arranged for the purpose of releasing overflow air when excessive winds are experienced. Aylor at col. 4, lines 48-51; FIGS. 1, 2. The wind gates (18) of Aylor and Applicant's tail fin are entirely different in structure and serve entirely different purposes.

Claims 19 and 20 depend from claim 18 and are therefore patentable over Li in view of Aylor for at least the same reasons as claim 18.

Accordingly, Applicants respectfully request that the rejection of claims 18-20 be withdrawn.

35 U.S.C. § 103 Rejection (Li in view of Williamson)

Claims 49-52 stand rejected under 35 U.S.C. § 103 as being obvious under Li in view of U.S. Patent No. 5,669,758 (Williamson).

Claims 49-52 depend from claims 1 and 13. Williamson does not remedy the deficiencies of Li with regard to claims 1 and 13, and therefore claims 49-52 are patentable over Li in view of Williamson for at least the same reasons as claims 1 and 13.

Accordingly, Applicants respectfully request that the rejection of claims 49-52 be withdrawn.

35 U.S.C. § 103 Rejection (Li in view of Williamson further in view of Gobel)

Claims 53-57 stand rejected under 35 U.S.C. § 103 as being obvious under Li in view of Williamson further in view of U.S. Patent No. 4,377,812 (Gobel). Claims 56 and 57 have been canceled.

Claims 53-55 depend from claims 1, 13, 49, and 51. Gobel does not remedy the deficiencies of Li and Williamson with regard to claims 1, 13, 49, and 51, and therefore claims 53-55 are patentable over Li in view of Williamson and Gobel for at least the same reasons as claims 1, 13, 49, and 52.

Accordingly, Applicants respectfully request that the rejection of claims 53-55 be withdrawn.

CONCLUSION

Accordingly, in view of the foregoing amendments and remarks, it is respectfully submitted that the application, including claims 1-6, 8-23, and 49-55, is in condition for allowance. An early notice of allowance is earnestly solicited.

Respectfully submitted,

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APPENDIX A